

New Concepts and Trends

- How Future Trends in Systems and Software Technology Bode Well for Enabling Improved Acquisition and Performance in Defense Systems

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Theme: Technology – Tipping the Balance

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The Software Engineering Institute - Improving the Practice of Engineering: Create, Apply and Amplify

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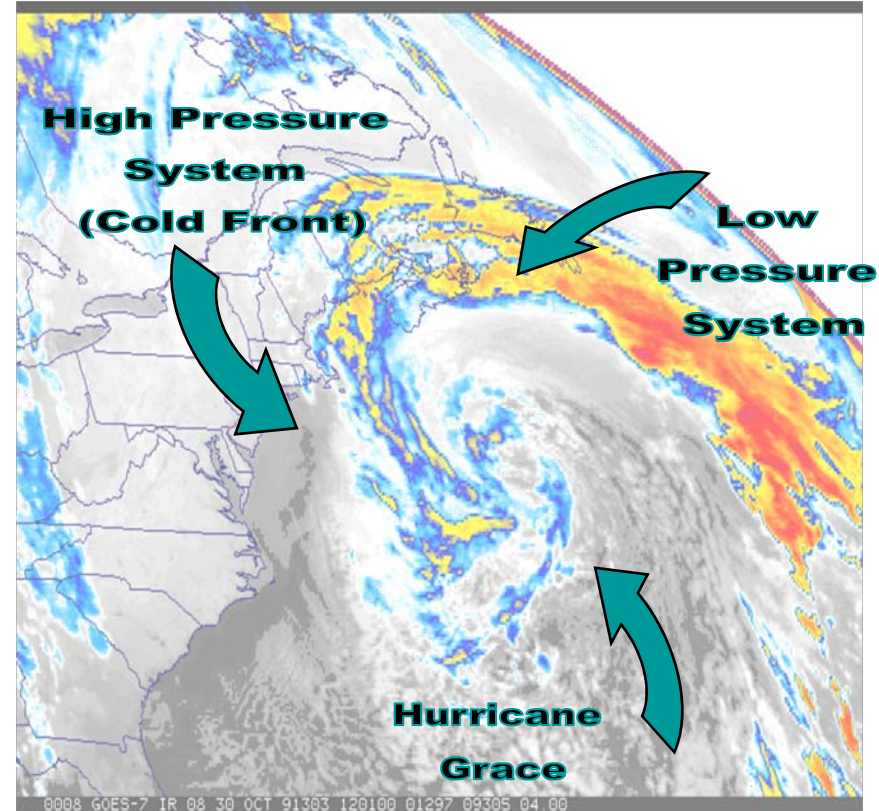
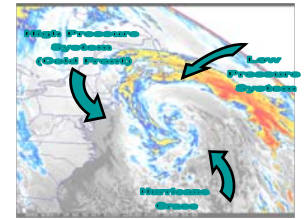
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Overview

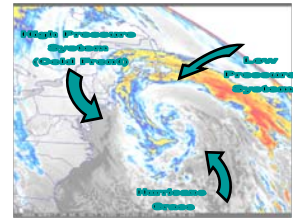
- Transformational Trends
 - Development
 - Acquisition
 - Human Element
 - Risk Management
 - Communications
- Ten Future Trends
- Wrap-up



“Perfect Storm” Event, October 1991
National Oceanic & Atmospheric Administration



Development: Need for Space, Air, Ground, Water, Underwater Software-Intensive Systems that are Interconnected



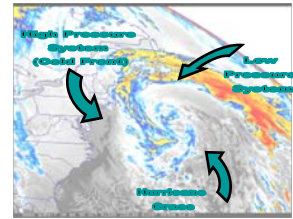
- Several million SLOC programs; “Hybrid” systems combining legacy re-use, COTS, new development
- Multi-contractor teams using different processes; dispersed engineering, development & operational locations
- New technologies create opportunities/challenges; products change/evolve, corporations mutate
- Business/operational needs change - often faster than full system capability can be implemented
- Skillset Shortfalls; Cost and schedule constraints
- Demands for increased integration, interoperability, system of system capabilities
- Enterprise perspectives/requirements; sustainment concerns



**Development Complexity of
Software-Intensive Systems
is Increasing**



Software Engineering Trends That Impact Systems Engineering



Traditional

- Standalone systems
- Mostly source code
- Requirements-driven
- Control over evolution
- Focus on software
- Stable requirements
- Premium on cost
- Staffing workable

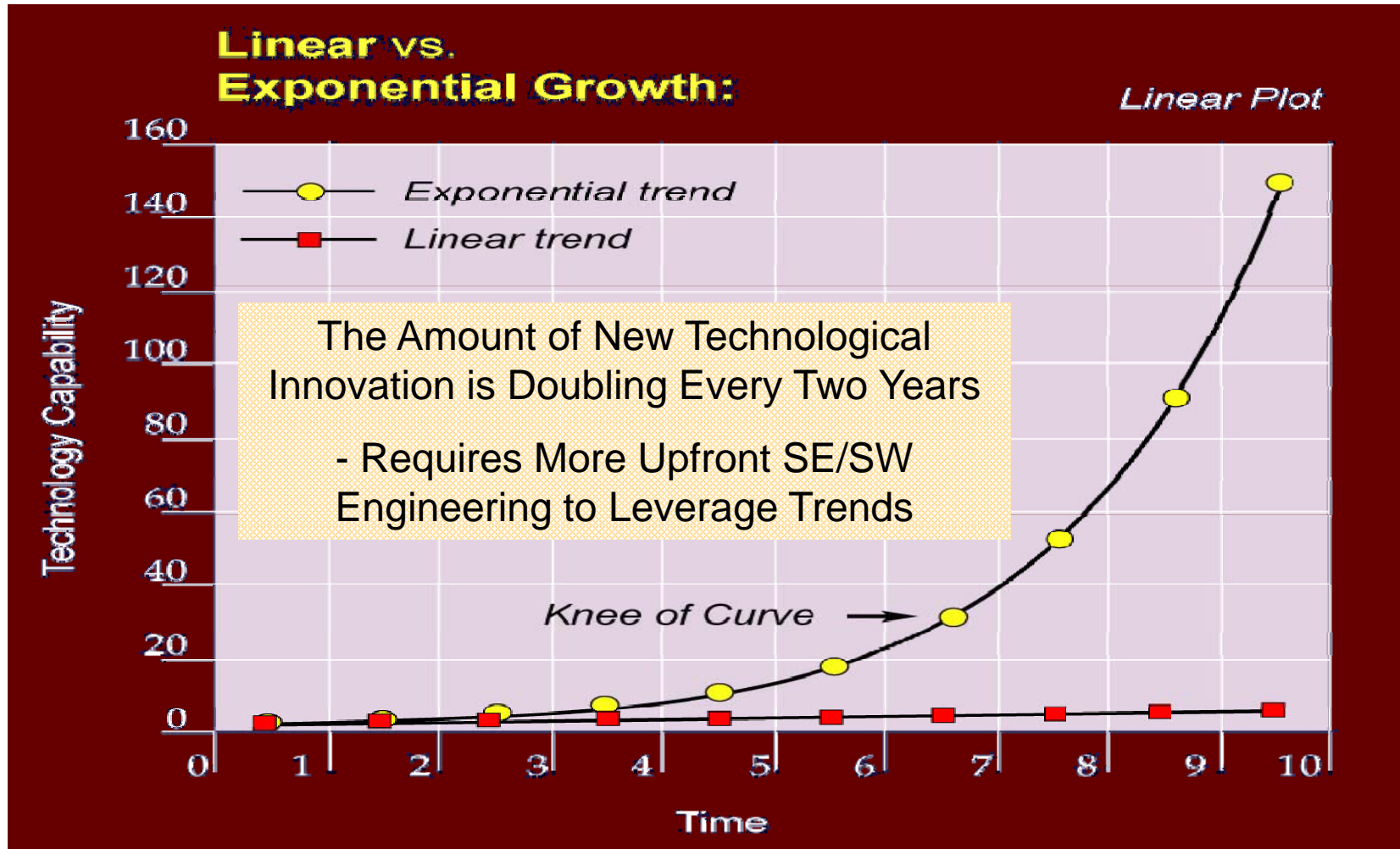
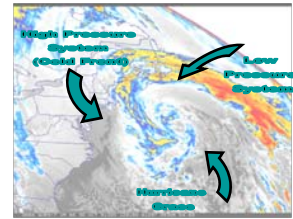
Future

- Everything connected-maybe
- Mostly COTS components
- Requirements are emergent
- No control over COTS evolution
- Focus on systems and software
- Rapid change
- Premium on value, speed, quality
- Scarcity of critical talent

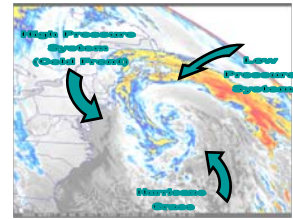
Emerging Dynamics of Bringing Systems and Software Engineering in Continued Partnership



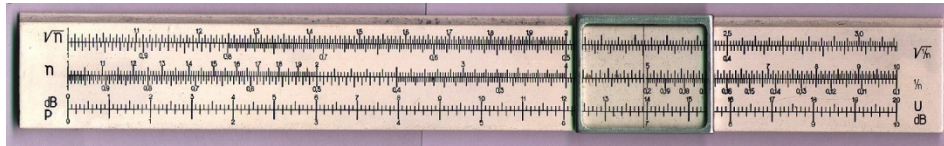
The Acceleration of Innovation in the 21st Century: - Impacting Both Defense and Society



Augustine's Law: Growth of Software - Order of Magnitude Every 10 Years



In The Beginning



1960's



**F-4A
1000
LOC**



1970's



**F-15A
50,000
LOC**



1980's



**F-16C
300K
LOC**



1990's



**F-22
1.7M
LOC**



2000+



**F-35
>6M
LOC**



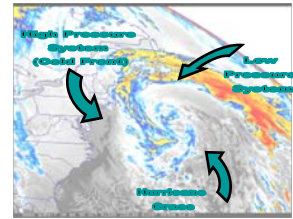
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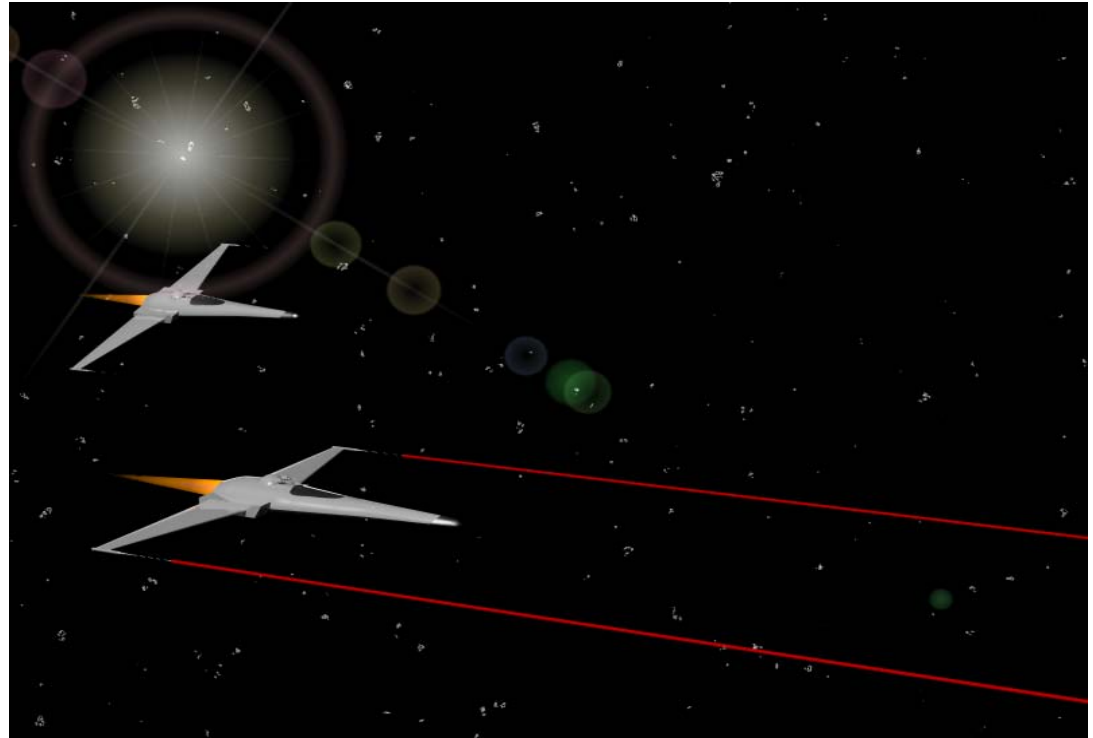
Trend & Implications: Augustine's Law Will Hold



2080?



F-50 - 4.7B Lines of Code



Need for increased functionality will be a forcing function to bring the fields of software and systems engineering closer together



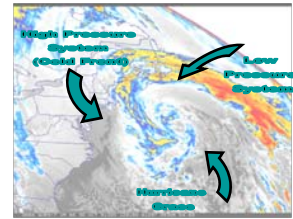
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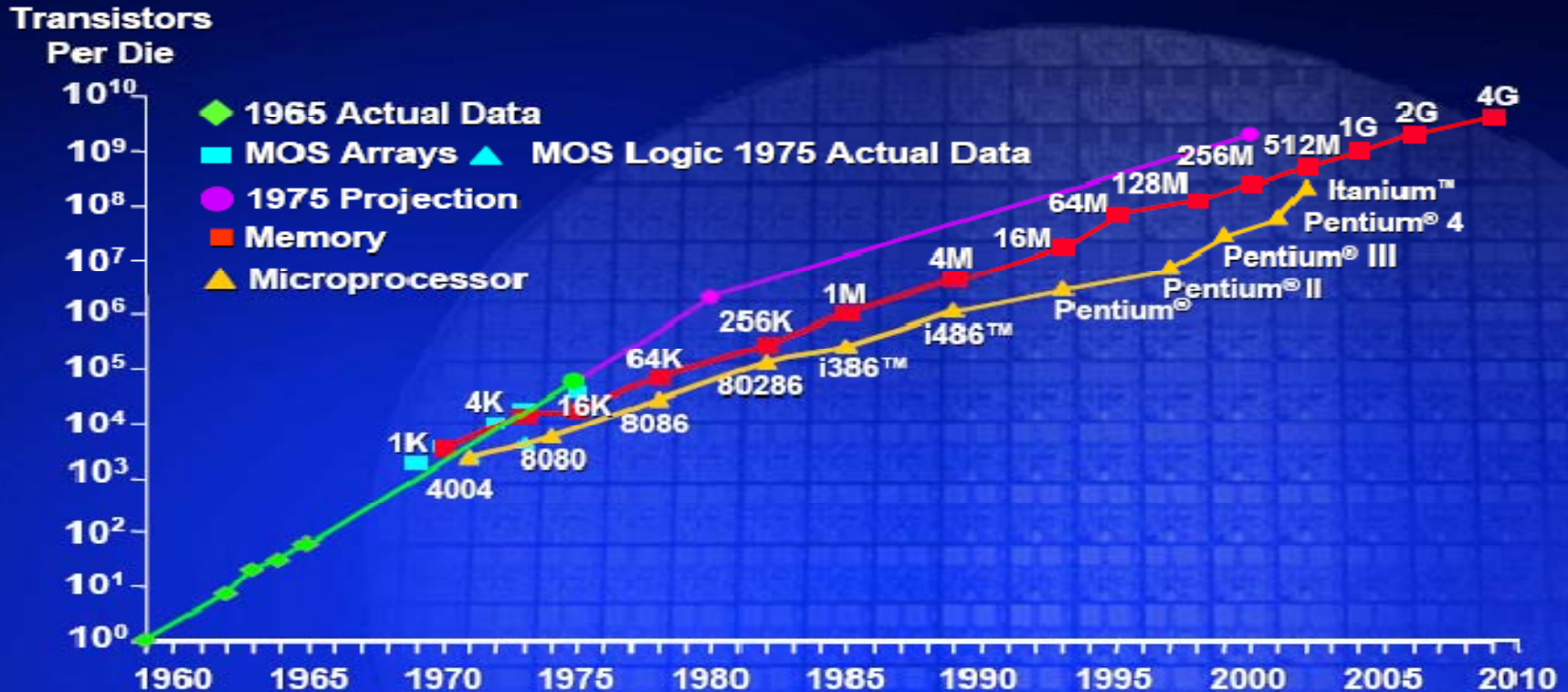
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Moore's Law: The Number of Transistors That Can be Placed on an Integrated Circuit is Doubling Approximately Every Two Years



Integrated Circuit Complexity



Source: Intel



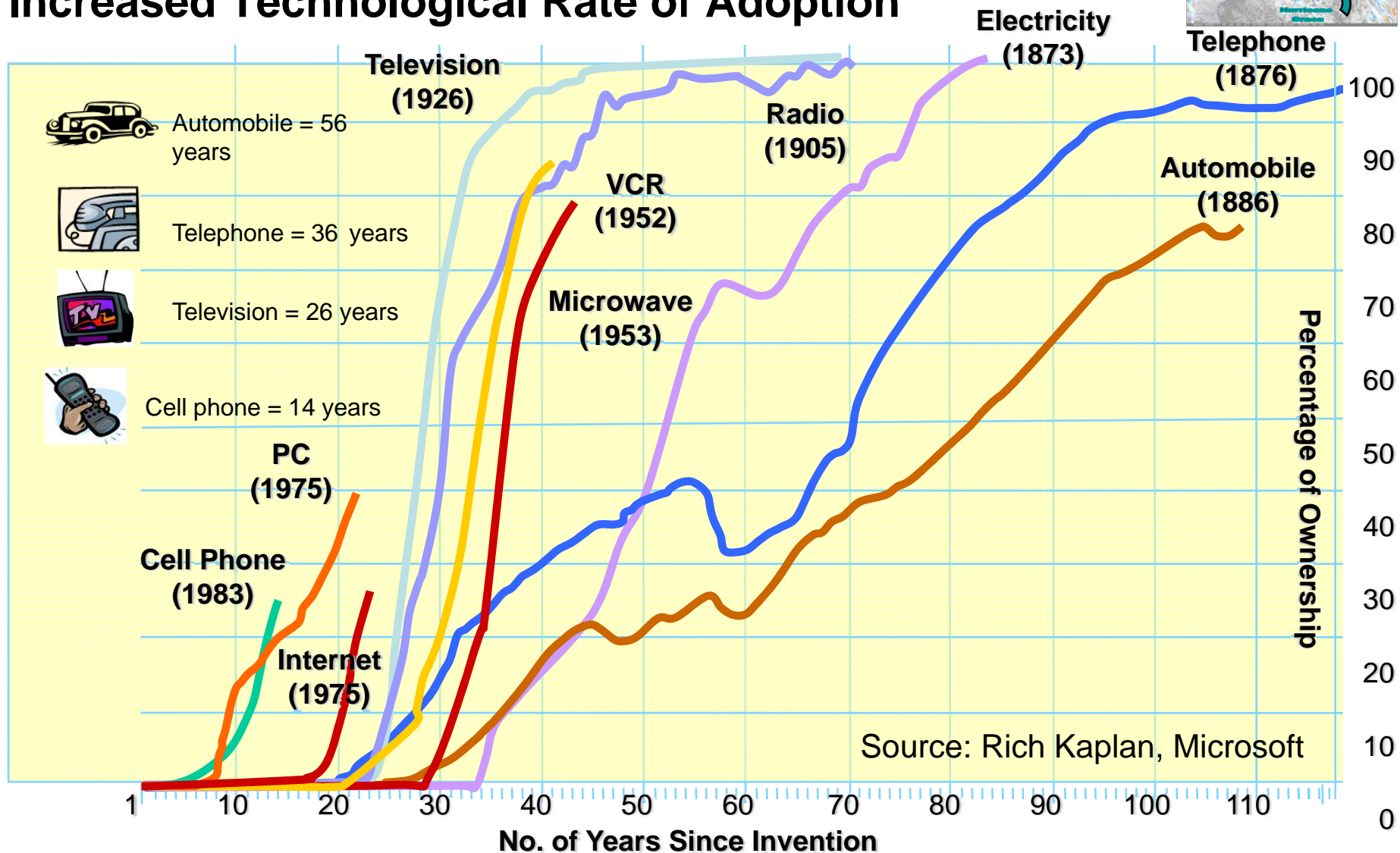
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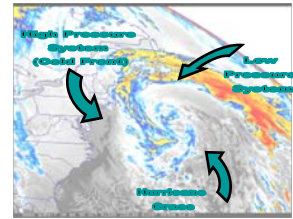
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Increased Technological Rate of Adoption



Relationship Between Complexity and Acquisition Success Improving and More Improvements are on the Way



Software is Growing in Complexity

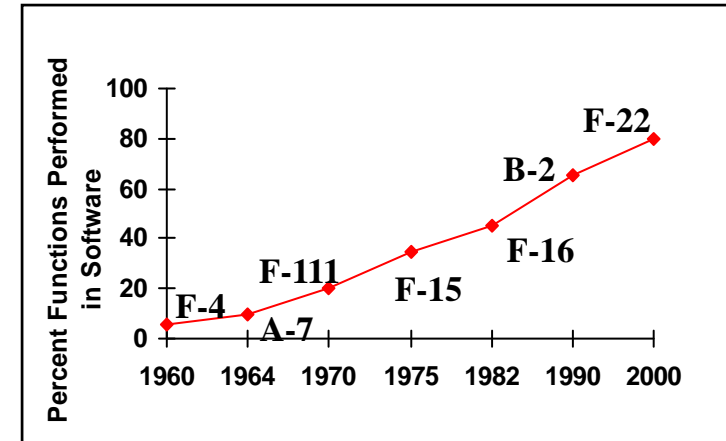
- 80% of some weapon system functionality is dependent upon software
- Consequences of software failure can be catastrophic

Software Acquisition is Difficult

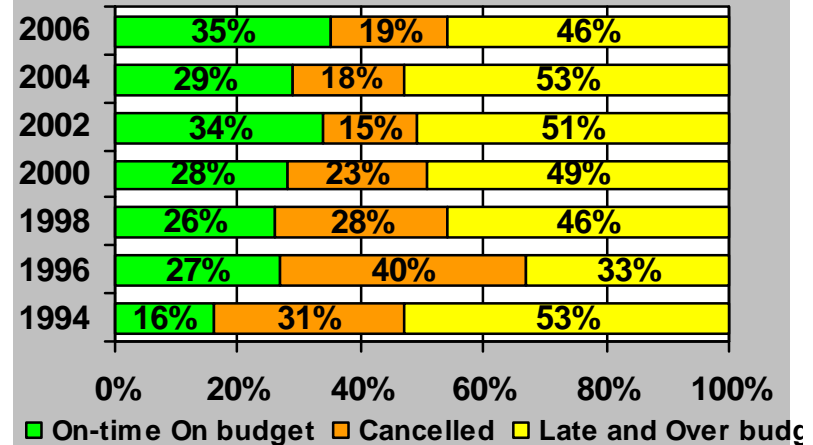
- 46% are over-budget (by an average of 47%) or late (by an average of 72%)
- “Successful projects” have 68% of specified features

Software is Pervasive

- IT Systems, C4ISR, Weapons, etc



Standish Group CHAOS Report



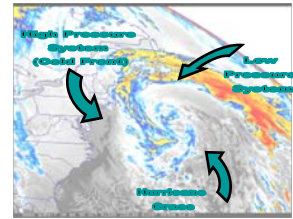
On-going Changes to the Acquisition Process Targeted at Correcting this Issue



The diagram illustrates the structure of a hurricane. It features a central 'Hurricane Core' surrounded by a 'Hurricane Eye'. The core is labeled as a 'High Pressure System (Cold Front)' and is associated with 'Low Pressure System' and 'Hurricane Winds'. Arrows indicate the flow of air from the high pressure system towards the low pressure system, showing the inward spiral of the winds.



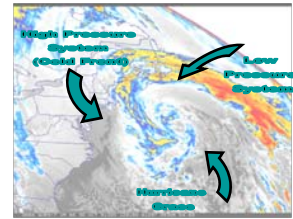
Acquisition: Effectively Managing Risk



A Key Challenge is How to Obtain a Better Alignment of Risk Among the Relevant Stakeholders



Acquisition Challenges: Some Drivers That Increase the Risk of Acquiring Software-Intensive Systems



Platform → **Enterprise**
Customer Emphasis

Requirements → **Objectives/
Capabilities**
Acquisition Model

**Dominant
Prime** → **Strategic
Teaming**
Program Execution

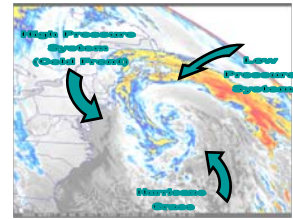
“Boxes” → **“Layers &
Stacks”**
Integration Challenge

Proprietary → **Plug & Play**
Architectures and Standards

***Need Exists to Address Both Sides, and Do So with Compressed Delivery
Schedules via Improvements in Systems/Software Engineering***

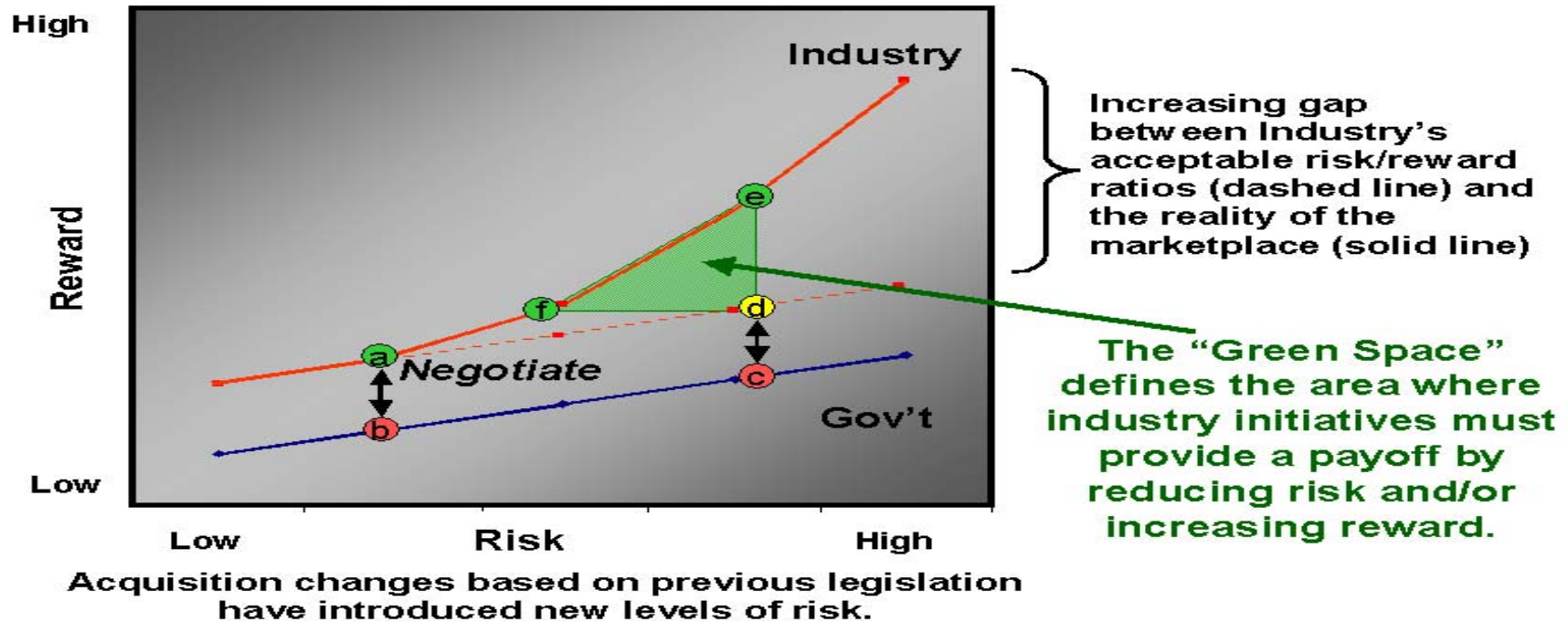


Increased Reliance on Acquirer/Developer to Reduce Risk by Effectively Navigating the Green/Acquisition Space



Navigating the “Green Space”

Risk-Reward Preferences



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Source: Nidiffer and Dolan, IEEE Software, Sept/Oct 2005



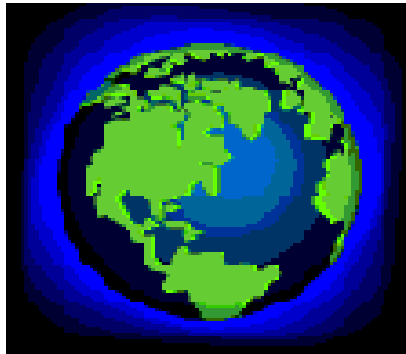
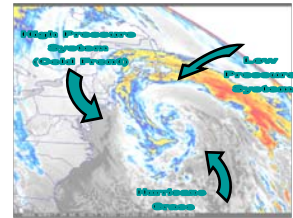
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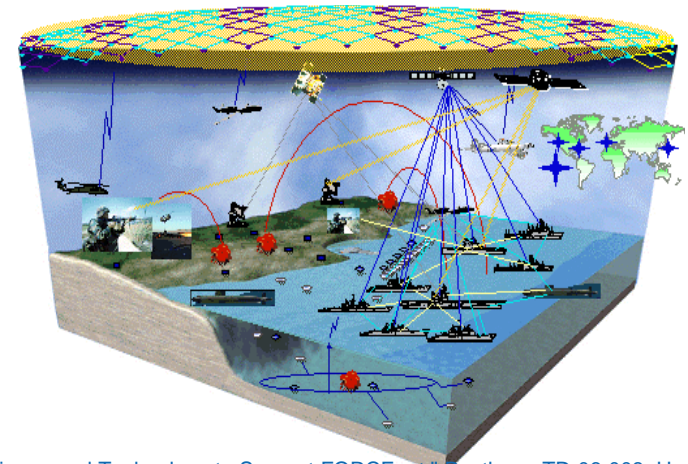
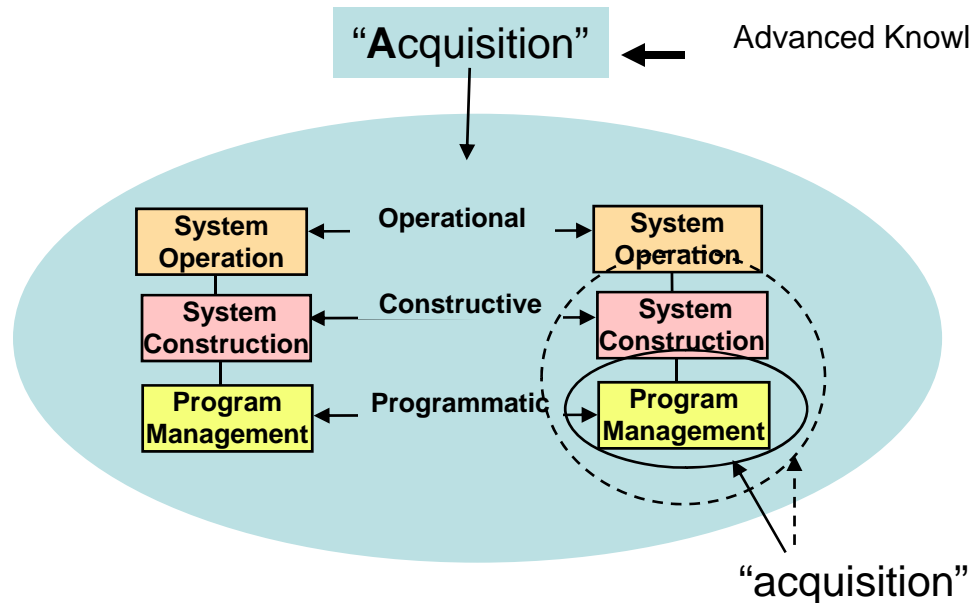
Acquisition Performance – Flexible Boundary-Crossing Acquisition Structure



2005 study confirmed*:

- In advanced knowledge-based organizations, management's desire for the flow of knowledge is greater than the desire to control boundaries
- Unlike the matrix organization, there is less impact on the dynamics of formal power and control
- **Important to measure the system in terms of user performance**

* Using Communities of Practice to Drive Organizational Performance and Innovation, 2005, APQ study



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Ref: Jim Smith, (703) 908-8221, jds@sei.cmu.edu



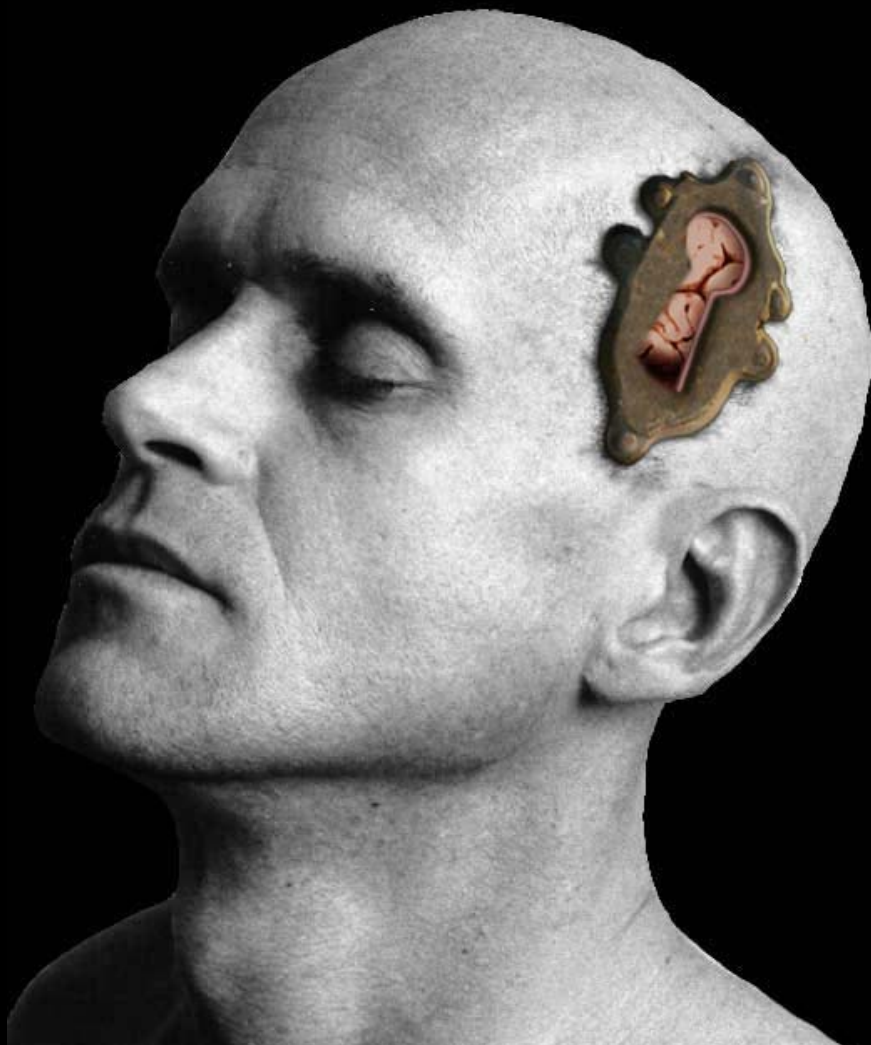
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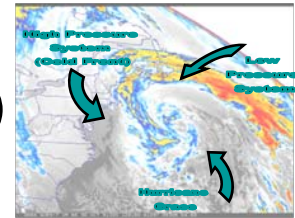
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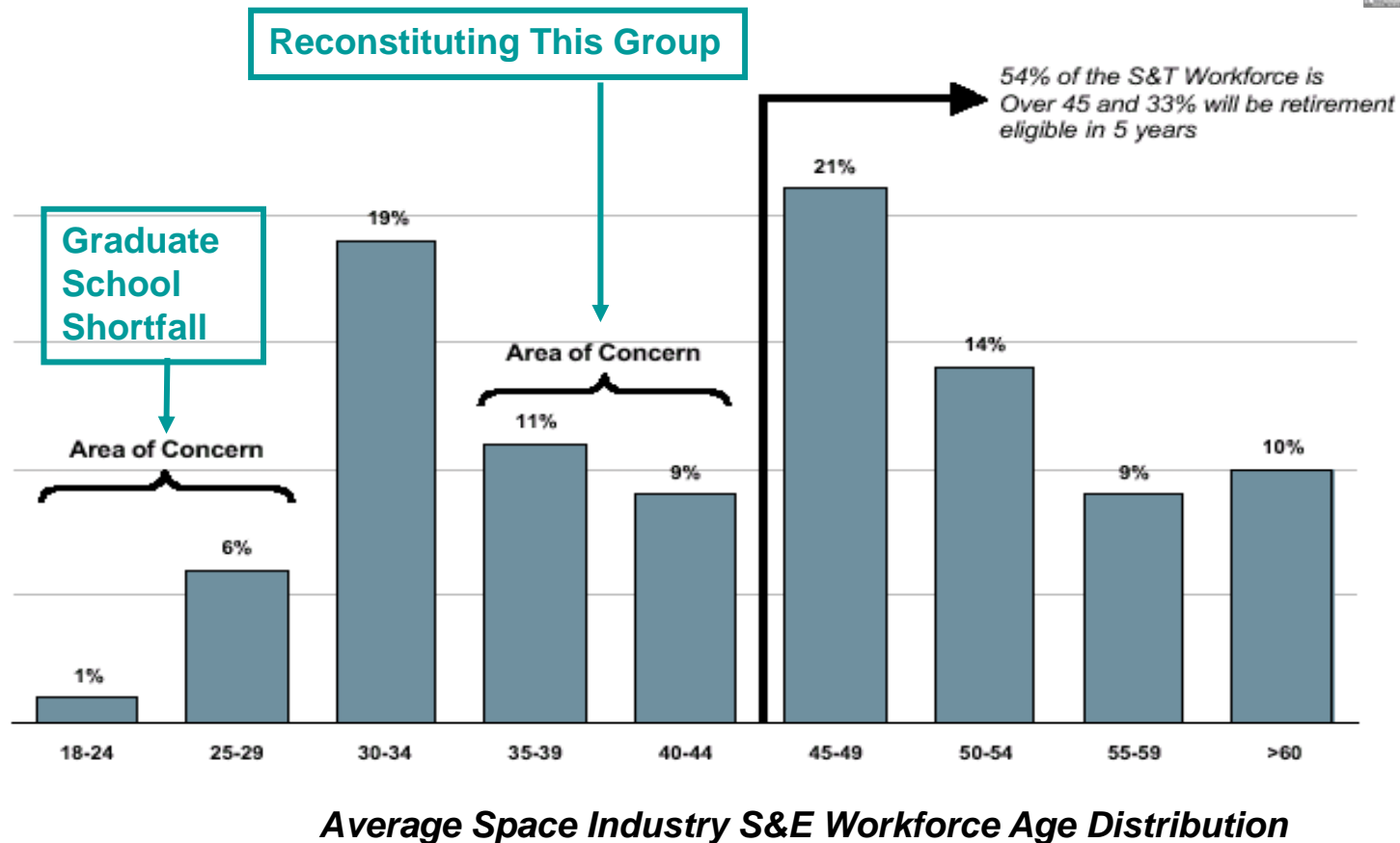
Human Element



The ability of organizations to compete will increasingly depend on the innovation of the human element



Society Drivers: Bimodal Demographics (Space Industry)



Trend: Industry/Gov't Will Increasingly Focus on Attracting, Training and Retaining Systems Engineering Talent



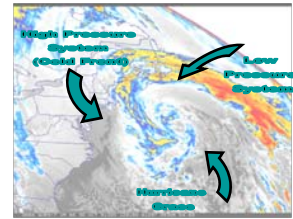
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Source: Lockheed Martin (0004305-001: AIAA SE Workforce Data. Frank Cappuccio VP & GM Skunk Works)

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Human Element Challenge: Bumpy Road at the Systems Engineering/Software Engineering Intersection



Source: Kurstedt, Harold, Newport Group - 2008



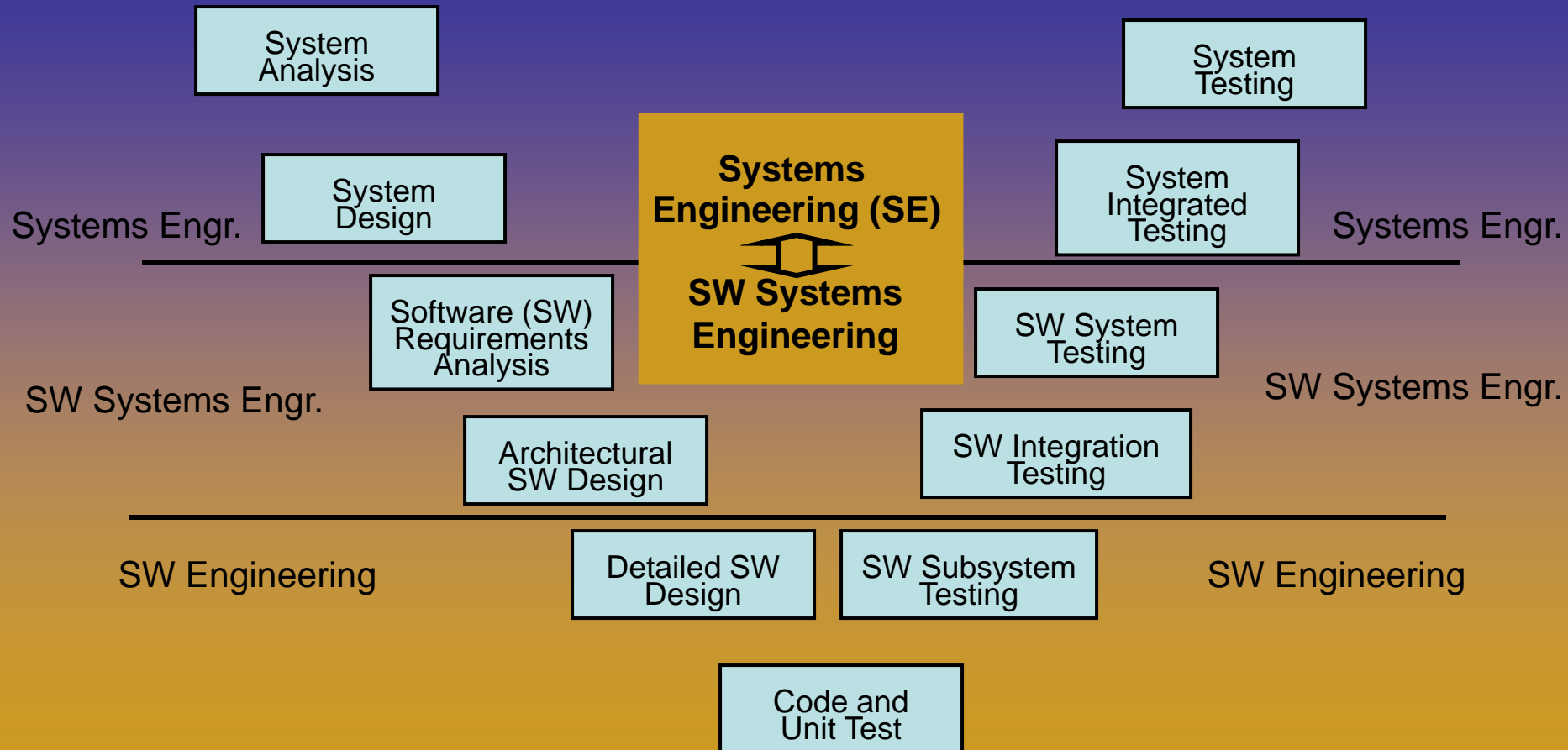
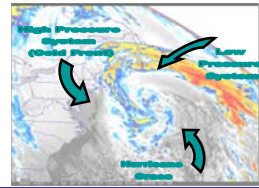
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Objective is for Software and Systems Engineering to Become More Integrated Versus Separated



OSD Initiative: Integrated Software and Systems Engineering Curriculum



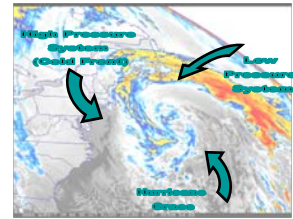
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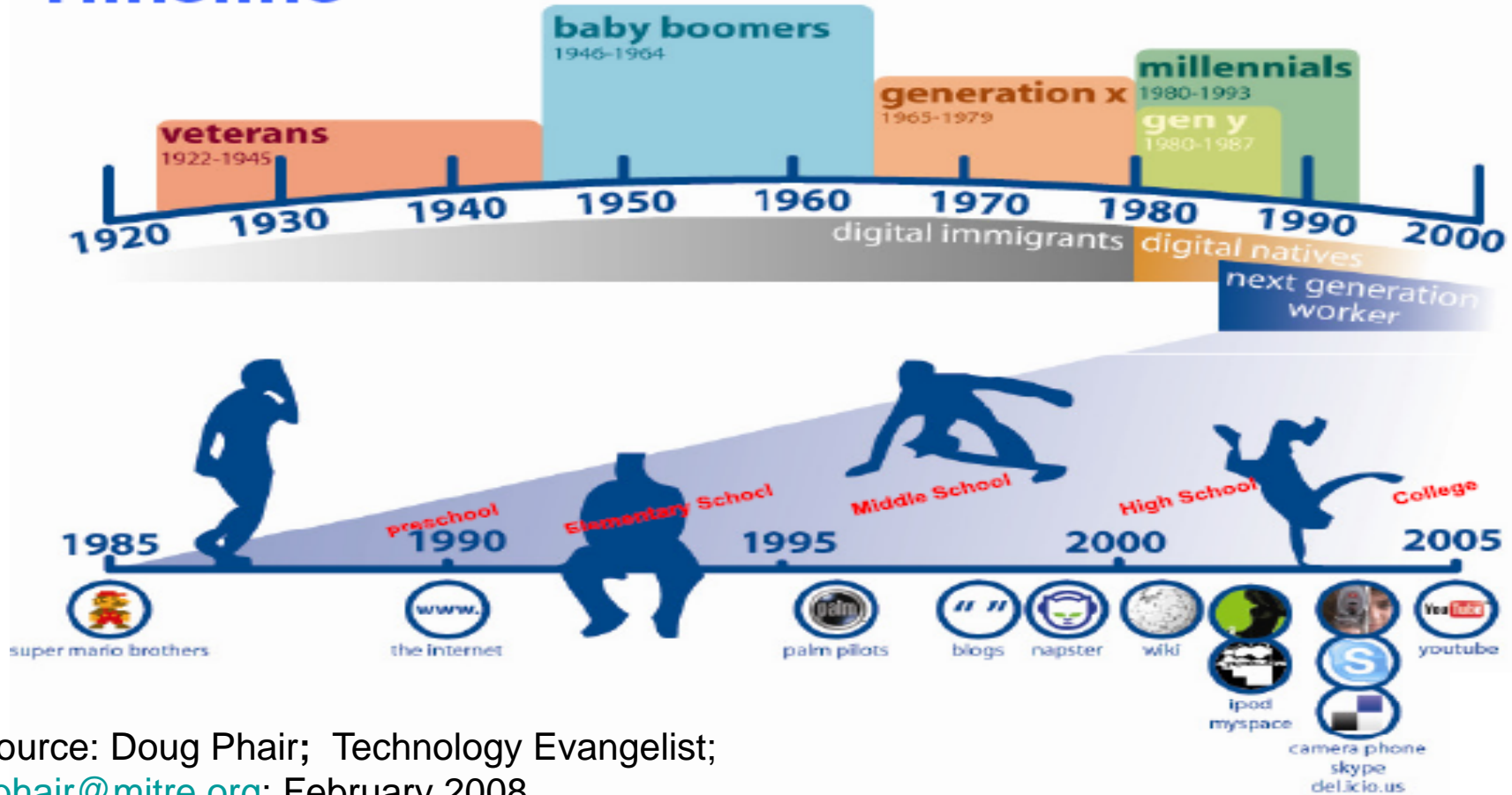
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Human Element in the Work-Space Environment



Timeline



Source: Doug Phair; Technology Evangelist;
dphair@mitre.org; February 2008



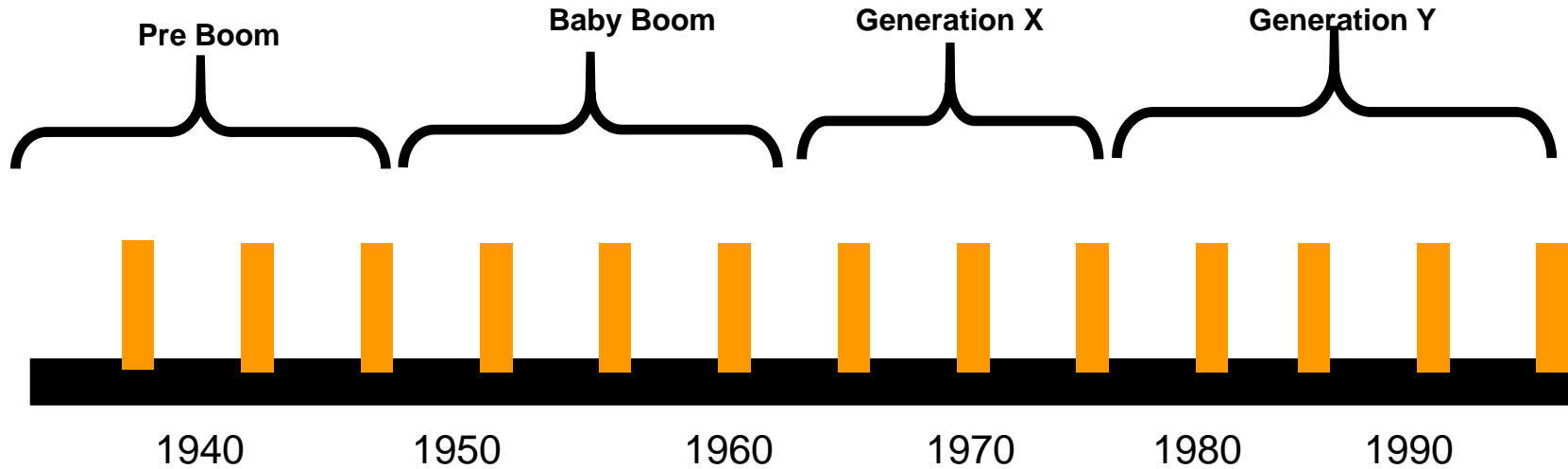
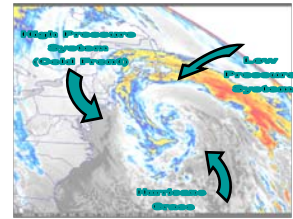
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Human Element: More Generation Y Workers Will Enter the Workplace



Generation Y Characteristics

- Born late 1970s to mid-1990s
- Larger than Generation X
- More ethnically diverse
- Technologically savvy

What Makes Generation Y Tick

- High Expectation of Employers
- Goals, Goals, Goals
- Desire for Immediate Responsibility
- Balance and Flexibility

Source: Cara Spiro, DAU, 2006



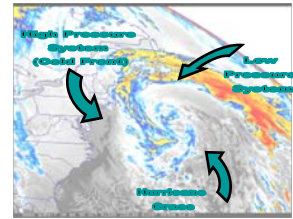
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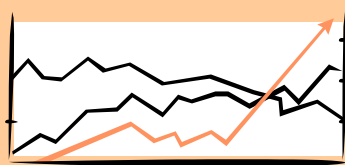
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Higher-Maturity Approaches to Process Improvement Are Important and Synergistic Trends



Data-Driven (e.g., Six Sigma, Lean)



Optimizing

Quantitatively Managed

Determine what your processes can do (Voice of Process)

- Statistical Process Control

Clarify what your customer wants (Voice of Customer)

- Critical to Quality (CTQs)

Identify and prioritize improvement opportunities

- Causal analysis of data

Determine where your customers/competitors are going (Voice of Business)

- Design for Six Sigma

Model-Driven (e.g., CMM, CMMI)



Determine the industry best practice

- Benchmarking, models

Compare your current practices to the model

- Appraisal, education

Identify and prioritize improvement opportunities

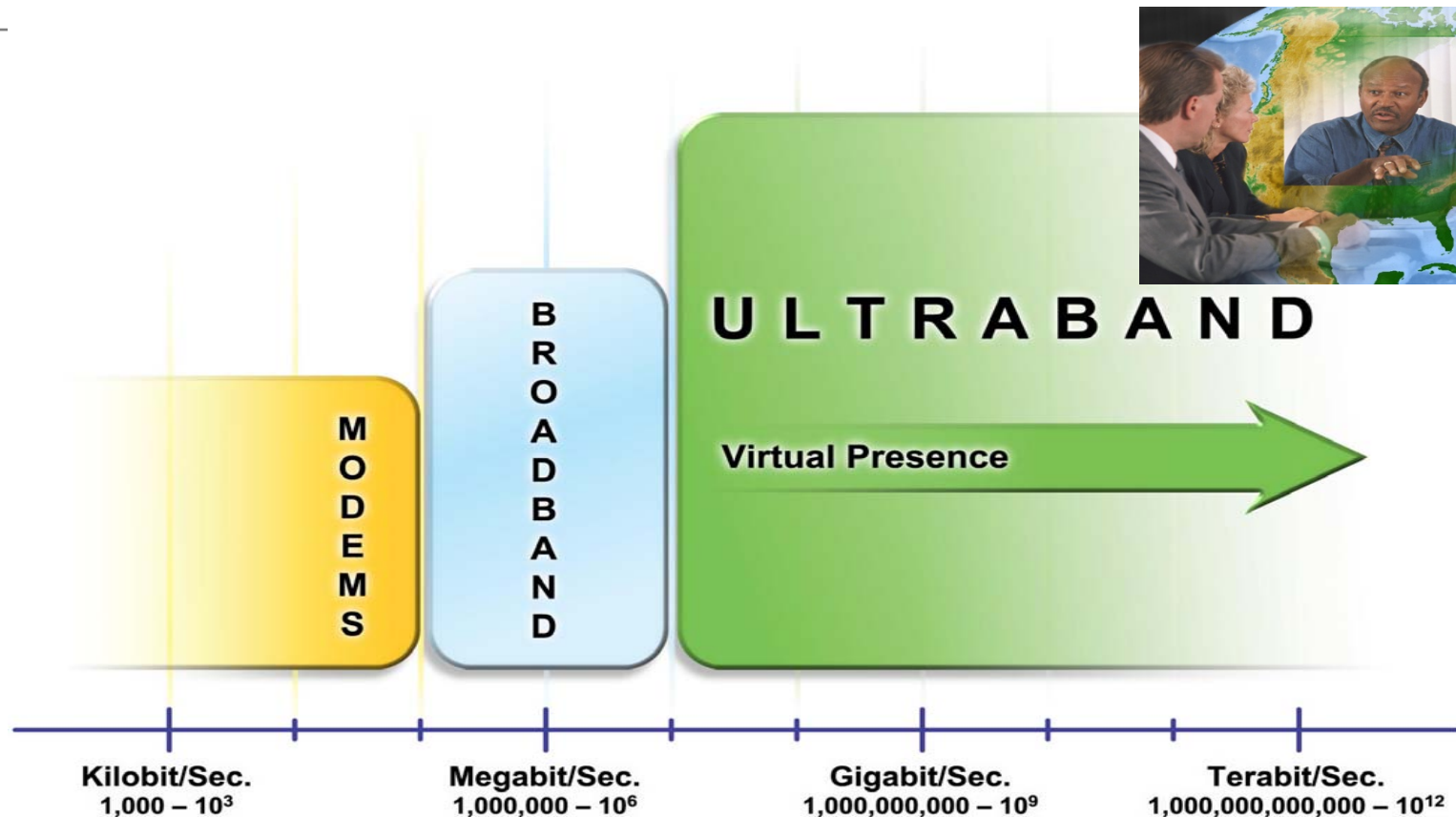
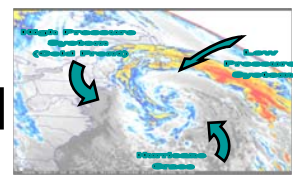
- Implementation
- Institutionalization

Look for ways to optimize the processes

CMMI and Six Sigma,
Siviy, et al, 2007, Addison Wesley



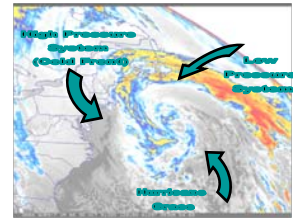
Communication: Increased Capabilities in the Digital Spectrum Enables Improvements in Communication and Collaboration



Rule #4: The best companies are the best collaborators*

* Friedman, Thomas L. *"The World Is Flat"*, Farrar, Straus and Giroux, 2005



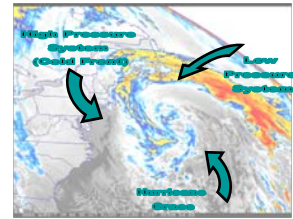


Systems and Software Engineering: Ten Trends

1. *Greater demands on systems and software engineers will stimulate growth in the field – nationally and internationally*
2. *Industry/Gov't will increasingly focus on attracting, training and retaining systems and software engineering talent – short and long run – with emphasis on providing a Generation Y work environment*
3. *Increased reliance on systems and software engineering processes and technologies to effectively manage the acquisition/"green" space*
4. *The laws of Augustine's and Moore will continue to hold and will continue to be a forcing function to bring the fields of software and systems engineering closer together*
5. *Improvements risk-reduction collaboration mechanisms will be significant enablers for increases in systems and software engineering communication and "decision velocity"*



Systems and Software Engineering: Ten Trends

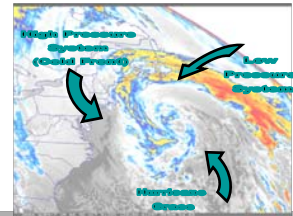


6. *Systems and software engineers will continually find way to innovative to reduce complexity*
7. *Increased importance of modeling and simulation*
8. *Increased customer requests for system and software engineering support will occur earlier in life cycle*
9. *Shift of systems and software engineering focus from the platform to the networks and ground systems*
10. *Process improvement will continue to be important!*





Recommended Readings



Buckman, Robert H. *Building a Knowledge-Driven Organization*. McGraw-Hill, New York, NY, 2004.

GAO Report: 08-467SP, Defense Acquisitions – Assessment of Selected Weapon Systems, March 2008

Chesbrough, Henry William. *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Harvard Business School Publishing Corporation, Boston, MA 2003.

Drucker, Peter. *Managing in the Next Society*. Truman Talley Books, New York, NY, 2003.

Friedman, Thomas L. “*The World Is Flat*”, Farrar, Straus and Giroux, 2005

Gates, William H. III “*Business @ The Speed of Thought – Using a Digital Nervous System*”, Time Warner Books, 1999

Kurstedt, Harold and Pamela, *Systems and Software Engineering Interfaces, Dealing with the Bumpy Roads*, Participant Guide, March 2008

Malone, Thomas. *The Future of Work: How the New Order of Business Will Shape Your Organization, Your Management Style and Your Life*. Harvard Business School Publishing, Boston, MA, 2004. See <http://ccs.mit.edu/futureofwork/>

Nidiffer, Kenneth E. and Doland, Diana “Evolving Distributed Project Management”, special issue *IEEE Software*, Sept/Oct 2005

Northrop, Linda. *Ultra-Large-Scale Systems – The Software Challenge of the Future*, Software Engineering Institute, June 2006

Rouse, William B. et al, *Understanding R&D Value Creation with Organizational Simulation*, Tennenbaum Institute, H. Milton Stewart School of Industrial & Systems Engineering, Georgia Institute of Technology, Atlanta, GA 30332-0205, Oct 2006

Wladawsky-Berger, Irving. “The Future of IT in an On-Demand World.” IBM Server Group, Keynote address at OSBC 2005. Archived at <http://www.itconversations.com/shows/detail495.html>

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